

## **CHAPTER 15**

### **SUMMARY, CONCLUSION AND PUBLIC POLICY IMPLICATIONS**

#### **15.1 Introduction**

The relationship between money supply and exchange rate has been studied for the economy of India over the period 1975(I) – 2006(IV) in chapter 4 through Chapter 14. A summary of the main findings on different aspects of such relationship is being presented below.

#### **15.2 Stationarity of Exchange Rate and Money Supply Series (in Chapter 4)**

The study in Chapter 4 testified that both exchange ( $e_t$ ) rate and money supply ( $m_t$ ) series

- (i) *had 'unit roots' and these were 'non-stationary.'*
- (ii) *did not entail 'deterministic trend'.*
- (iii) *non-stationarity of the series at levels was not due to the structural shift in their structure.*
- (iv) *exchange rate series was stationary upon first differencing.*
- (v) *exchange rate was 'Differenced Stationary (DS)' and it was not 'Trend Stationary (TS)'. So, exchange rate is  $I(1)$  series.*
- (vi) *first differenced series of money supply ( $M_t$ ) was non-stationary with time as a variable in the maintained regression equation and it followed 'random walk'.*
- (vii) *both  $E_t$  and  $M_t$  series were  $I(1)$ .*

#### **15.3 Cointegration between Exchange Rate and Money Supply (in Chapter 5)**

Chapter 5 has been devoted to examine the existence of *Cointegration* between two non-stationary variables, viz. exchange rate and money supply. The study involves the *Engle-Granger Method of Testing Cointegration* and *Johansen Tests of Cointegration*. The study of Cointegration presented in Sections 5.3 – 5.6.4 shows that

- (i) *Rupee/Dollar exchange was not Cointegrated with the money supply at level, and,*
- (ii) *money supply was also not Cointegrated with the Rupee/Dollar exchange rate at level.*
- (iii) *first differenced series of Rupee/Dollar exchange rate was cointegrated with first differenced series of money supply, and, conversely,*
- (iv) *first differenced series of money supply was also cointegrated with first differenced series of Rupee/Dollar exchange rate.*
- (v) *exchange rate and money supply series were  $CI(1,0)$ .*

The *Cointegration* between the Rupee/Dollar exchange rate and the money supply in India has important economic implications. Study of *cointegration* enquires into the existence of equilibrium relationship postulated by the economic theory and examines whether the model is well defined. The existence of the *cointegration* in our study, therefore, implies that exchange rate and the money supply in India maintained a long-run relationship over the period of the study.

Study of *cointegration* can be used directly to test the underlying theory. As our variables are *cointegrated*, we cannot negate the Dornbush model or the *Monetary Model of Exchange rate (MAER)* in Indian economy over the period of the study.

Now we seek to enquire into the stability of such relationship between these variables. This constitutes the subject matter of our study in the next chapter.

#### **15.4 Dynamics of Short-Run Shocks and the Stability of Long-Run Relationship between Exchange Rate and Money Supply**

*Cointegration* study in Chapter 5 confirms the existence of long-run relationship between Rupee/Dollar exchange rate and money supply in India. However, it is imperative to know if such relationship is stable. Stability of the long-run relationship is established if the short-run shocks transmitted through  $E_t$  or  $M_t$  channel converge before long. The stability of the long-run relationship is studied through the estimation of *Vector Error Correction Model (VECM)*.

From the study with the *VEC Model* for  $E_t$  and  $M_t$  in the economy of India, it is found that

- (i) *the long-run relationship, that exchange rate maintained with money supply, was stable. The shocks, transmitted through exchange rate channel, had significant impact on the long-run relationship and these provided damped oscillations. Consequently, the short-run dynamics of exchange rate defined an 'equilibrium' process.*
- (ii) *the long-run relationship, which money supply maintained with exchange rate, was stable. The shocks, transmitted through monetary channel, failed to exert any appreciable impact on such long-run relationship. Consequently, the short-run dynamics of monetary growth defined a 'stable equilibrium process'.*
- (iii) *there did exist 'Uni-directional' short-run Granger Causality running from money supply to Rupee/Dollar Exchange Rate.*
- (iv) *exchange rate, consequently, failed to Granger cause money supply in the short-run. Exchange rate emerged as an exogenous variable in the equation for money supply.*

### **15.5 Causal Relationship Between Rupee/Dollar Exchange Rate and Money Supply in Chapter 7**

The causal relationship between Rupee/Dollar exchange rate and money supply has been studied with the *Vector Autoregression Model (VAR)* in Chapter 7. Main findings of this study are as follows:

- (i) *Two period back domestic money supply led to depreciation of exchange rate (i.e., rise in Rupee/Dollar Exchange rate). This findings supports the main proposition of the MAER model of exchange rate determination.*
- (ii) *A rise in Rupee/Dollar exchange rate led to a rise in Rupee/Dollar exchange rate in the next period (quarter). This feature of exchange rate is a pointer to the occurrence of almost continuous depreciations of Indian Rupee against US Dollar over the period of study.*

- (iii) *Money supply ‘Granger Caused’ exchange rate over the period of the study.*
- (iv) *Current money supply was positively related to the three period back money supply. This finding explains an important feature of Indian monetary policy. In Indian economy expansionary monetary policy had been operative over the period of the study. Money supply increased continuously, especially after the bank nationalization. Thus overall increase in money supply failed to conform to Friedman’s K% point rule. The univariate structure underlying the distribution process for money supply, therefore indicates, an underlying inclination for maintaining a changing (increasing) mean value over the period concerned.*
- (v) *Exchange rate failed to ‘Granger Caused’ money supply during this period.*

*It is, therefore, observed in section 7.12 through section 7.15 that over the period concerned*

- a) money supply ‘Granger Caused’ exchange rate.*
- b) exchange rate failed to ‘Granger Cause’ money supply.*
- c) there did exist, therefore, ‘Uni-directional Causality’ running from money supply to exchange rate.*

## **15.6 Intervention Analysis through the Study of Impulse Response Functions in Chapter 8**

The VAR model, studied in Chapter 7, consists of two endogenous variables, namely, exchange rate and money supply. Consequently, the model considers two types of shocks. Some shocks are transmitted through the monetary channel while others are transmitted through the exchange rate channel. In Chapter 8 we examined the responses of exchange rate to such shocks. Besides, we sought also to examine the relative importance of these shocks in explaining variations in Rupee/Dollar exchange rate over time. From the *Intervention Analysis through the Study of Impulse Response Functions*, we have obtained following observations.

- (i)  $E_t$ , in response to any impulse transmitted through previous period exchange rate channel, quickly attained long-run equilibrium level after a very short lived variation.
- (ii)  $E_t$ , in response to monetary impulse, attained the long-run equilibrium level after significant short-run variations in several successive periods.
- (iii)  $E_t$ , exhibited **overshooting phenomenon** in response to impulse, transmitted through monetary channel.
- (iv) the impulse response of  $E_t$  depicted a balancing trend in view of the fact the rise in  $E_t$  was followed by subsequent declines in  $E_t$ . Such counteracting response depicted a trend for the maintenance of long-run stability in the dynamics of exchange rate movement.
- (v) Short-run variations in money supply were mainly due to impulses, transmitted through the channel of money supply.
- (vi) Exchange rate shocks were weaker than the monetary shocks in generating variations in money supply.

These findings give forth two important features of responses of exchange rate and money supply to different types of shocks. These are stated below:

- a) Shocks, transmitted through the monetary and the exchange rate channels, were short-lived and these failed to bring forth significant changes in both the exchange rate and monetary profiles.
- b) Monetary shocks were more dominant than exchange rate shocks in the matter of generating short-run variations in exchange rate and money supply. Monetary shocks led to the emergence of a new long-run initial base for money supply.

### **15.7 Intervention Analysis through the Study of Variance Decomposition in Chapter 9**

While *Impulse Response Functions* trace the effects of a shock to one endogenous variable on the other variables in the **VAR Model**, *Variance Decomposition* separates the variations in an endogenous variable into the component shocks.

The main findings from the study of Variance Decomposition in chapter 9 are as follows:

- (i) *Exchange rate shocks constituted the long-run base for the Rupee/Dollar exchange rate.*
- (ii) *Short-run variations in exchange rate were mainly a 'monetary phenomenon' since monetary shocks accounted for a significant part of variations in exchange rate.*
- (iii) *Exchange rate maintained a 'stable' long-run equilibrium relation with lagged exchange rate and money supplies since its responses reverted to long-run path before long following impulses, transmitted through all the channels considered.*
- (iv) *Exchange rate shocks failed to produce any variations in monetary growth.*
- (v) *Monetary shocks, on the other hand, were the predominant factor behind the variations in money supply over a 20 quarter period.*

*These observations also testify for the 'Unidirectional Causal relation', running from money supply to exchange rate in the economy of India over the period 1975(I) -2006(IV)*

## **15.8 Study of Granger Causality between Exchange Rate and Money Supply in Chapter 10**

The estimated VAR model shown in Chapter 7 gives a hint about the direction and nature of causality between variables concerned. In the VAR model the specification of lags structures for both the variables is required to be uniform. Consequently, the model is 'over parameterized'. Such an 'Unrestricted VAR Model', therefore, appears to be less informative about the causality between variables. In such case 'Restricted VAR Model' may be of great help. A variant of such 'Restricted VAR Model' is used in 'Granger Causality Approach'. With this end in view, we have sought to study, in Chapter 10, the 'casualty' between exchange rate money supply in the line suggested by Granger Causality tests. In the Granger causality study, we have the following observations.

It is observed from our study in sections 10.8 – 10.14 that over the period of study

- (i) exchange rate was '**Granger Caused**' by money supply.
- (ii) money supply was also '**Granger Caused**' by exchange rates. However, the strength of such causal effect was very insignificant.
- (iii) there did exist, therefore, '**Bi-directional Causality**' between exchange rate and money supply.

This finding of '**Bi-directional Causality**' is in striking contrast with the finding of '**Uni-directional causality**' running from money supply to exchange rate in our study with the **Unrestricted VAR Model** in Chapter 7. We, therefore, sought to enquire further into the nature and direction of causality through '**Spectral Analysis**' in Chapter 11. The '**Frequency Domain**' study is expected to supplant and supplement the '**Time Domain**' study.

### **15.9 Spectral Analysis for Further Confirmation of the Nature of Granger Causality (in Chapter 11)**

We have sought to examine the causal relation between Rupee/Dollar exchange rate and money supply in the Chapter 11 through the '**Spectral Analysis**'. This will enable us to re-examine the nature and direction of '**Granger Causality**', as obtained in Chapters 7 through 10, between the variables concerned.

In this '**Spectral Analysis**

- (i) '**Univariate Periodograms**' for  $E_t$  and  $M_t$ , confirmed that  $M_t$  and  $E_t$  were '**Stationary**' i.e.  $E_t \sim I(0)$  and  $M_t \sim I(0)$ . Consequently,  $e_t \sim I(1)$  and  $m_t \sim I(1)$ .
- (ii) '**Auto Spectram**' confirmed the presence of periodicity in  $E_t$  and  $M_t$  across different frequency and the incidence of statistically significant auto-regressive structure for the endogenous variables in the VAR model studied in Chapter 7.

- (iii) *The ‘Cospectrum’ for  $E_t$  and  $M_t$  exhibited ‘periodicity’ at period 3. This confirmed that  $E_t$  and  $M_t$  were ‘Cointegrated’ and the long-run relationship between  $E_t$  and  $M_t$  was ‘Stable’.*
- (iv) *The ‘Coherence Spectrum’ for  $E_t$  and  $M_t$  confirmed that there did exist strong ‘Coherence’ in their co-movements over the period of study.*
- (v) *The ‘Gain Spectrum’ for the variables confirmed the existence of ‘Unidirectional Granger Causality’ from Money Supply to Exchange Rate over the period of study.*
- (vi) *The ‘Phase Spectrum’ for the variables further confirmed that Money Supply ‘Granger Caused’ Exchange Rate in India over the period of study.*

#### **15.10 The Relationship Between Money Supply and Exchange Rate in the ‘Basket-Peg Period’ of Exchange Rate in Chapter 12**

The causal relation enquired through the Chapter 7 to Chapter 11 covers the historical dataset ranging period 1975 (I) - 2006 (IV) when India underwent two different exchange rate regimes, namely,

- a) *the Regime of Basket Peg Exchange Rate System*, during 1974 to 1992 (I), and
- b) *the Regime of Market Determined Exchange Rate System*, from September 1994 to till date.

The policy and practices that *Reserve Bank of India (RBI)* with regard to the controlling and stabilizing the value of Indian Rupee in terms of major international currencies, like Dollar, were markedly different under these two exchange rate regimes. Therefore, it becomes pertinent for us to enquire into the role of money supply in India for stabilizing the value of Rupee/Dollar exchange rates under different regimes. In chapter 12 and 13, we have addressed these issues in detail.

We have enquired into the relationship between exchange rate and money supply in the **Basket peg period** of exchange rate covering period 1975(I) - 1992(I) with **VAR Model** and *Intervention Analysis through Variance Decomposition Method* in Chapter 12. It has been observed in chapter 12 that, in the economy of India over the period 1975 (I) – 1992(I).

- (i) *money supply variations ‘Granger Caused’ exchange rate variations,*
- (ii) *exchange rate variations also ‘Granger Caused’ money supply variations,*
- (iii) *there did exist, therefore, **Bi-directional Granger Causality** between exchange rate and money supply,*
- (iv) *‘Variance Decomposition’ analysis also testifies for the persistence of ‘**Bi-directional Granger Causality**’ between exchange rate and money supply provided no structural shift occurred regarding practice of determining the Rupee/Dollar exchange rate in the economy.*

*All these findings are in conformity with the findings obtained in Chapter 10 when ‘Structural VAR’ Model was estimated in order to ascertain the nature and direction of ‘Granger Causality’ between the variables concerned over the historical dataset covering the period 1975(I) – 2006(IV).*

### **15.11 Study of Causality Between Exchange Rate and Money Supply in the ‘Market Determination’ Regime in Chapter 13**

The regime of the *‘Pegged Exchange Rate System’* was over in March, 1991 and henceforth India moved towards the *Market Determined Exchange Rate System*. With the adoption of the *‘Flexible Market Determination System’* for exchange rate, the relationship between exchange rate and money supply underwent some changes. We have enquired into the relationship between exchange rate and money supply in the **‘Market Determined Exchange Rate Era’** in Chapter 13.

It is observed in the chapter 13 that

- (i) *estimated VAR model indicates that ‘**Uni-directional Granger Causality**’ running from money supply to exchange rate existed over the period of study.*

- (ii) *exchange rate appeared to be the ‘Exogenous Variable’ in the VAR system.*
- (iii) *Variance Decomposition Study also confirms the ‘Uni-directional Causality’ running from money supply to exchange rate.*
- (iv) *exchange rate shocks failed to account for any significant variations in money supply.*

### **15.12 Theoretical Explanations of Findings of Granger Causality under ‘Basket Peg’ and ‘Market Determination’ (Chapter 14)**

We have found that the regime under the ‘**Pegged Exchange Rate System**’ is marked by the presence of *Bi-directional Causality between exchange rate and money supply*. In this regime variation in *money supply Granger Caused* variations in *exchange rate* which, in turn, ‘*Granger Caused*’ further variations in money supply.

Again, the regime under the ‘**Floating Exchange Rate regime**’ is marked by the presence of ‘**Uni-directional Causality**’ running from money supply to exchange rate. Exchange rate appeared to be completely ‘**exogenous**’ to the VAR system.

These findings testify for

- (i) the existence of ‘*structural shift*’ in the historical dataset, and consequently
- (ii) the ‘*causal*’ relations between money supply and exchange rate varied in two different sub periods.

In Chapter 14 we have enquired into the theoretical backgrounds explaining the variations in such causal relations’ over different exchange rate regimes.

In the ‘**Basket-Peg system**’, the official exchange rate (spot exchange rate) of foreign currencies in terms of rupee was determined. These rates were ‘**official**’ or ‘**target**’ rates. These rates were often revised following the changes in the value of international currencies. However, once the ‘*official*’ or ‘*target*’ rates were fixed, the Reserve Bank of India tried to

maintain it. Under such '**Crawling Peg**' system, '*arbitrage*' activities emerged. The '*arbitrage*' activities were the special features in the '**Basket-Pegging**' system.

Under '**Basket-Pegging**' System, '*arbitrage*' activities emerged when '*market*' exchange rate deviated from the '*quoted*' exchange rate. Such variation in exchange rate, through '*arbitrage*' activities, caused variations in money supply in subsequent periods. Consequently, *exchange rate variations were found to 'Granger Cause' variations in money supply.*

In the '**Basket-Pegged System**', *money supply affected and was affected by exchange rate. Initially, variations in money supply 'Granger Caused' exchange rate variations. These variations in exchange rate, in turn, generated 'arbitrage' activities and eventually 'Granger Caused' variation in money. Consequently, the 'Basket-Pegged' system was marked by the existence of Bi-directional Granger Causality between money supply and exchange rate.*

The '**Market Determination System**' represented '*Free Float*' for exchange rate in which market forces determined exchange rate. The Reserve Bank of India the country did not interfere with such determination. Consequently, the system was marked by the absence of '*arbitrage*' activities in the market following any changes in money supply and exchange rate.

In chapter 12, the VAR model with equations (12.1) and (12.2) has been estimated (section 12.4). The endogenous variables are money supply and exchange rate. Joint estimations of these equations consider the impact of the shocks of any endogenous variable on the other endogenous variable. This allows us to examine the effects of the shocks, transmitted through the monetary channel, on exchange rate. Similarly, it offers us a scope of examining the impact of the shocks, transmitted through exchange rate channel, on money supply. Thus, the VAR model enables us to examine, under the '*Basket Pegging System*',

- (i) the effect of money supply variation on exchange rate, and
- (ii) the effect of '*arbitrage*' activities on money supply.

Consequently, under the '**Basket Pegging System**', '**Bi-directional Granger Causality**' was observed and this observation conformed to the theoretical findings in section 14.3.

In chapter 13, the same VAR model has been estimated under the '*Floating System*'. In this system, there did exist no 'arbitrage' activities following changes in exchange rate. Consequently, '*Uni-directional Granger Causality*' running from money supply to exchange rate was observed. This observation is in conformity with the theoretical proposition observed in section 14.

### **15.13 Conclusions**

All these findings give forth some specific features of the relationship between exchange rate and money supply in the economy over the period of the study [1975(I) – 2006(IV)]. The historical datasets exhibited the following features concerning the relationship of exchange rate money supply.

#### ***(a) Stable Long- run Relationship Between Exchange Rate and Money Supply***

*Exchange rate maintained a 'stable' long-run relationship with money supply. The long-run base for the exchange rate was constituted by real factors which entered into the 'information set' on the basis of which 'adaptively expected values' for exchange rate were formed. The AR(p) structure for the exchange rate underlies the 'Adaptive Expectation Equation' for exchange rate.*

#### ***(b) Short-run Variations in Exchange rate are Monetary Phenomena***

*Exchange Rates exhibited significant short-run variations around the long-run equilibrium base over the period concerned. These short-run variations in exchange rates were predominantly explained by variations in money supply. Contributions of monetary shocks to the short-run variations in exchange registered a rise over time. Consequently, the short-run variations in exchange rate appeared to be a 'Monetary phenomenon'.*

#### ***(c) Uni-directional Granger Causality Running From Money Supply to Exchange Rate***

*Variations in money supply, therefore, were found to Granger cause the variations in exchange rates. However, money supply appeared to be 'non-activist' and therefore, was found to be insulated to the variations in exchange rate. Exchange rate emerged as an 'exogenous variable' in the system. This account for the fact that exchange rate variations*

failed to '**Granger cause**' variations in money supply. Thus the historical dataset is marked by the presence of '**Uni-directional Causality**' running from money supply to exchange rate.

**(d) 'Overshooting' of Exchange Rate**

Exchange rates exhibited '**Overshooting**' following monetary shocks. The dynamic path of exchange rate, as shown in the Impulse Response Functions, delineates a steep rise (depreciation of rupee in terms of dollar) in response to an increase in money supply, followed by a fall in next periods. Consequently, the time path of exchange rate is 'damped oscillatory' by nature. This is in conformity with the resolution of the '**Dornbusch Model of Exchange Rate**'.

**(e) 'Structural Shift' in Historical Dataset**

The historical dataset is marked by the presence of two different system of exchange rate determinations like

- (i) **Basket-Peg System** [From 1975(I) – 1992(I) ]
- (ii) **Market-Determination System** [From 1994(III) to till date.]

These two systems essentially portrayed a '**paradigm shift**' with respect to the process of determination of exchange rate. The '**Basket-Peg**' system essentially represented a '**Crawling Peg**' system while the '**Market Determination**' system constituted the '**Floating**' of exchange rate in the market. Consequently, parameters estimated with the historical dataset were found to be '**unstable**'.

**(f) Bi-directional Granger Causality Between Exchange Rate and Money Supply in the 'Basket-Peg' System**

In the '**Basket-Peg System**' money supply '**Granger caused**' depreciation in exchange rate. '**Market**' exchange rate fell below the '**quoted**' exchange rate. Such divergence between the '**quoted**' and '**market**' exchange rates triggered '**arbitrage**' activities in the market. These activities '**Granger caused**' a fall in money supply leading to a consequent rise in exchange rate. Money supply decline finally to the initial level and exchange rate reverts back to the original level. Thus, the '**Basket-Pegged**' exchange rate system is marked by the presence of a '**Bi-directional Causality**' between exchange rate and money supply.

**(g) Uni-directional Granger Causality Running from Money Supply to Exchange Rate under Floating System**

Rise in money supply in the 'Floating System' 'Granger caused' fall in exchange rate (i.e., depreciation of rupee). But 'Floating System' is marked by the absence of any 'arbitrage activities' following exchange rate variations. Consequently, there was no 'counteracting change' in money supply and, therefore, exchange rate failed to 'Granger Cause' money supply variations. Thus 'Uni-directional Granger Causality' from money supply to exchange rate appeared to be the specific feature of the 'Floating Exchange Rate' regime.

**(h) 'Overshooting' of Exchange Rate even under the Floating Exchange Rate System**

Rise in money supply 'Granger Caused' a rise in the rupee price of dollar (i.e., depreciation of rupee) and Impulse Response Functions for exchange rate were marked by 'damped oscillations around the long-run equilibrium base. This testified for the 'Overshooting' or 'excess variability' in exchange rate caused by variations in money supply.

It may, therefore, be concluded that in the Indian economy over the period of study 1975(I) – 2006(IV)

- (i) Short-run variations in exchange rates are a **Monetary Phenomenon**.
- (ii) Variations in money supply 'Granger Caused' 'Overshooting' or 'Excess Variability' in exchange rate.
- (iii) Exchange rate 'Granger caused' money supply during the 'Basket-Pegged Regime'. However, in the 'Floating Exchange Rate Regime' exchange rate failed to 'Granger Cause' money supply.

Consequently, these findings conform to the main propositions of the MAER (Monetary Theory of Exchange Rate) theory and of the Dornbush Model of Exchange Rate.

#### 15.14 Public Policy Implications

**'Stability'** of the exchange rate is the pre-condition for raising **'net-export'** and attracting **'foreign investment'** in any country. **'Theories of Foreign Investment'** amply show that any depreciation of rupee at the time of repatriation of foreign capital deters foreign investment. Stability of rupee is, therefore, urgently needed for promoting foreign investment.

The present study shows that the Rupee/Dollar exchange rate is affected by the domestic supply of money. Consequently, the stability of Rupee/Dollar exchange rate, *ceteris paribus*, requires that the supply of money in India remain stable under the **'Floating Exchange Rate Regime'**. Moreover, stability of the money supply in India is required for avoiding **excess variability** of Rupee/Dollar exchange rate.

The study, therefore, indicates that the monetary authority in India is required to maintain stability in money supply. The **k % rule**, advocated by Friedman, may be followed by the monetary authority in order to ensure **stability** and **avoid excess variability** of Rupee/Dollar exchange rate.